

Claims:

1. A copolymer comprising

(a) from 90 to 99.999 weight percent of propylene units,

5 (b) from 0.00 to 8 weight percent of olefin units other than propylene units,

(c) from 0.001 to 2.000 weight percent of α,ω -diene units,

wherein the copolymer has

10 • a weight average molecular weight in the range from 50,000 to 2,000,000;

• a crystallization temperature in the range from 118 °C to 135 °C;

and

15 • a melt flow rate in the range from 0.1 dg/min to 100 dg/min.

2. The copolymer of claim 1 wherein the weight percent of α,ω -diene units present in the copolymer is from 0.005 to 1.5.

20 3. The copolymer of claim 1 wherein the weight percent of α,ω -diene units present in the copolymer is from 0.005 to 1.0.

4. The copolymer of claim 1 wherein the olefin is selected from the group consisting of ethylene, C_3 - C_{10} α -olefins, diolefins and mixtures thereof.

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5. The copolymer of claim 4 wherein the olefin is selected from the group consisting of ethylene, butene-1, pentene-1, hexene-1, heptene-1, 4-

methyl-1-pentene, 3-methyl-1-pentene, 4-methyl-1-hexene, 5-methyl-1-hexene, 1-octene, 1-decene, 1-undecene, and 1-dodecene.

5 6. The copolymer of claim 1 wherein the melting temperature minus the crystallization temperature is 25-40 °C.

7. A propylene copolymer, comprising:

propylene and 1,9-decadiene, said copolymer having:

- 10 - a weight average molecular weight in the range from 100,000 to 750,000;
- a melt flow rate in the range from 1 dg/min to 35 dg/min;
- a crystallization temperature in the range from 118°C to 126°C;
- a melting point selected from one of less than 160°C or at least two crystalline populations wherein the melting point ranges for one
15 crystalline population are distinguishable from the melting point range of another crystalline population by a melting point range from 1°C to 8°C, wherein in said at least two crystalline populations one of said crystalline populations has a melting point from 152°C to 158°C and another said crystalline population has a
20 melting point from 142°C to 148°C;
- a hexane extractable level (as measured by 21 CFR 177.1520(d)(3)(i)) of the copolymer of less than 1.0 wt%; and
- a ratio of extensional viscosity at break to linear viscosity of at least 3.5 at strain rates from 0.1 second⁻¹ to 1.0 second⁻¹; and,
25 - a recoverable compliance in the range of from 7 to 42 cm²/dyne.

8. The copolymer of claim 7 wherein the melting temperature minus the crystallization temperature is 25-40 °C.

30 9. A propylene copolymer, comprising:

- (a) from 90 to 99.995 weight percent propylene;
- (b) from 0.005 to 0.0375 weight percent of an α,ω diene selected from one of 1,7-octadiene or 1,9-decadiene, wherein said copolymer has:
 - a weight average molecular weight in the range from 100,000 to 750,000;
 - a melt flow rate in the range from 1 dg/min to 35 dg/min;
 - a crystallization temperature in the range from 118°C to 126°C;
 - a melting point of less than 160°C;
 - a recoverable compliance in the range of from 7 to 17 cm²/dyne.

10. The copolymer of claim 9 wherein the melting temperature minus the crystallization temperature is 25-40 °C.

11. A copolymer comprising

- (a) from 90 to 99.999 weight percent of propylene units,
- (b) from 0.01 to 8 weight percent ethylene units,
- (c) from 0.001 to 2.000 weight percent α,ω -diene units, wherein the copolymer has
 - a weight average molecular weight in the range from 50,000 to 2,000,000,
 - a crystallization temperature in the range from 118 °C to 135 °C and
 - a melt flow rate in the range from 0.1 dg/min to 100 dg/min.

12. The copolymer of claim 11 wherein the weight percent of α,ω -diene units present in the copolymer is from 0.005 to 1.5.

13. The copolymer of claim 11 wherein the weight percent of α,ω -diene units present in the copolymer is from 0.005 to 1.0.
- 5 14. The copolymer of claim 11 further including olefin units selected from the group consisting of ethylene, C_3 - C_{10} α -olefins, diolefins and mixtures thereof.
- 10 15. The copolymer of claim 11 further including olefin units selected from the group consisting of ethylene, butene-1, pentene-1, hexene-1, heptene-1, 4-methyl-1-pentene, 3-methyl-1-pentene, 4-methyl-1-hexene, 5-methyl-1-hexene, 1-octene, 1-decene, 1-undecene, and 1-dodecene.
- 15 16. The copolymer of claim 11 further defined as having at least two crystalline populations.
- 20 17. The copolymer of claim 16 wherein one of the crystalline populations has a first melting point in a first melting point range and another crystalline population has a second melting point in a second melting point range and wherein the first melting point range is distinguishable from the second melting point range by a temperature range of from 1°C to 8°C.
- 25 18. The copolymer of claim 16 wherein one of the crystalline populations has a melting point in the range from 152 °C to 158 °C and another crystalline population has a melting point in the range from 142 °C to 148 °C.
19. The copolymer of claim 11 wherein the melting temperature minus the crystallization temperature is 25-40 °C.
20. A copolymer comprising:
- 30 (a) from 90 to 99.999 weight percent of olefin units and

(b) from 0.001 to 2.000 weight percent of α,ω -diene units

wherein the copolymer has

- a weight average molecular weight in a range from 50,000 to 2,000,000;
- a melt flow rate in a range from 0.1 dg/min to 100 dg/min;
- the copolymer has at least two crystalline populations wherein one of the crystalline populations has a first melting point in a first melting point range and another crystalline population has a second melting point in a second melting point range and wherein the first melting point range is distinguishable from the second melting point range by 1°C to 8°C.

21. The copolymer of claim 20 wherein the crystallization temperature is from 115-135 °C.

22. A copolymer comprising:

a) from 90 to 99.999 weight percent of olefin units and

b) from 0.001 to 2.000 weight percent of α,ω -diene units

wherein the copolymer has

- a weight average molecular weight in a range from 50,000 to 2,000,000;
- a melt flow rate in a range from 0.1 dg/min to 100 dg/min;
- the copolymer has one crystalline population having a melting point in the range from 152 °C to 158 °C and another crystalline population having a melting point in the range from 142 °C to 148 °C.

23. The copolymer of claim 22 wherein the crystallization temperature is from 115-135 °C.

24. A copolymer comprising:

(a) from 90 to 99.999 weight percent of olefin units and

(a) from 0.001 to 2.000 weight percent of α,ω -diene units

wherein the copolymer has

- a weight average molecular weight in a range from 50,000 to 2,000,000;
- a melt flow rate in a range from 0.1 dg/min to 100 dg/min;

the copolymer melting temperature minus the crystallization temperature is 25-39 °C.

25. The copolymer of claim 24 wherein the crystallization temperature is from 115-135 °C.

26. A propylene copolymer, comprising:

- a) propylene;
- b) olefin units other than propylene;
- c) α, ω diene units;

wherein said propylene copolymer has:

- a weight average molecular weight in the range from 50,000 to 2,000,000;
- a crystallization temperature in the range from 115°C to 135°C;
- a melt flow rate in the range from 0.1 dg/min to 100 dg/min;
- a melting point less than 165°C;
- a hexane extractable level (as measured by 21 CFR 177.1520(d)(3)(i)) of the copolymer of less than 2.0 wt%;
- a ratio of extensional viscosity at break to linear viscosity of at least 2.5 at strain rates from 0.1 second⁻¹ to 1.0 second⁻¹; and
- a recoverable compliance in the range of from 7 to 42 cm²/dyne.

27. The propylene copolymer of claim 26, wherein said olefin units other than propylene are selected from one of ethylene, butene-1, pentene-1, hexene-1, heptene-1, 4-methyl-1-pentene, 3-methyl-1-pentene, 4-methyl-1-hexene, 5-methyl-1-hexene, 1-octene, 1-decene, 1-undecene, or 1-dodecene; wherein said α , ω diene is selected from one of 1,6-heptadiene, 1,7-octadiene, 1,8-nonadiene, 1,9-decadiene, 1,10-undecadiene, 1,11-dodecadiene, 1,12-tridecadiene, 1,13-tetradecadiene; wherein said copolymer has:

- a weight average molecular weight in the range from 70,000 to 1,000,000;
- a crystallization temperature in the range from 115°C to 130°C;
- a melting point less than 160°C;
- a hexane extractable level of the copolymer of less than 1.0 wt%; and
- a ratio of extensional viscosity at break to linear viscosity of at least 3.0.

28. The propylene copolymer of claim 26, wherein said olefin other than propylene is ethylene, said α , ω diene is selected from one of 1,7-octadiene, or 1,9-decadiene;

wherein said copolymer has:

- a weight average molecular weight in the range from 100,000 to 750,000;
- a crystallization temperature in the range from 118°C to 126°C;
- a melting point less than 160°C;
- a hexane extractable level of the copolymer of less than 1.0 wt%; and
- a ratio of extensional viscosity at break to linear viscosity of at least 3.5.

29. The propylene copolymer of claim 26, wherein said olefin other than propylene is ethylene, said α , ω diene is 1,9-decadiene;

wherein said copolymer has:

- a weight average molecular weight in the range from 100,000 to 750,000;
- at least two crystalline populations wherein the melting point ranges for one crystalline population are distinguishable from the melting point range of another crystalline population by a melting point range from 1°C to 16°C;
- a melting point less than 160°C;
- a hexane extractable level of the copolymer of less than 1.0 wt%; and
- a ratio of extensional viscosity at break to linear viscosity of at least 3.5.

30. The copolymer of claim 29, wherein in said at least two crystalline populations one of said crystalline populations has a melting point from 152°C to 158°C and another said crystalline population has a melting point from 142°C to 148°C.

31. The copolymer of claim 20 wherein the weight percent of α , ω -diene units present in the copolymer is from 0.005 to 1.5.

32. The copolymer of claim 22 wherein the weight percent of α , ω -diene units present in the copolymer is from 0.005 to 1.5.

33. The copolymer of claim 24 wherein the weight percent of α , ω -diene units present in the copolymer is from 0.005 to 1.5.

34. The copolymer of claim 20 wherein the weight percent of α,ω -diene units present in the copolymer is from 0.005 to 1.0.
35. The copolymer of claim 22 wherein the weight percent of α,ω -diene units present in the copolymer is from 0.005 to 1.0.
36. The copolymer of claim 24 wherein the weight percent of α,ω -diene units present in the copolymer is from 0.005 to 1.0.